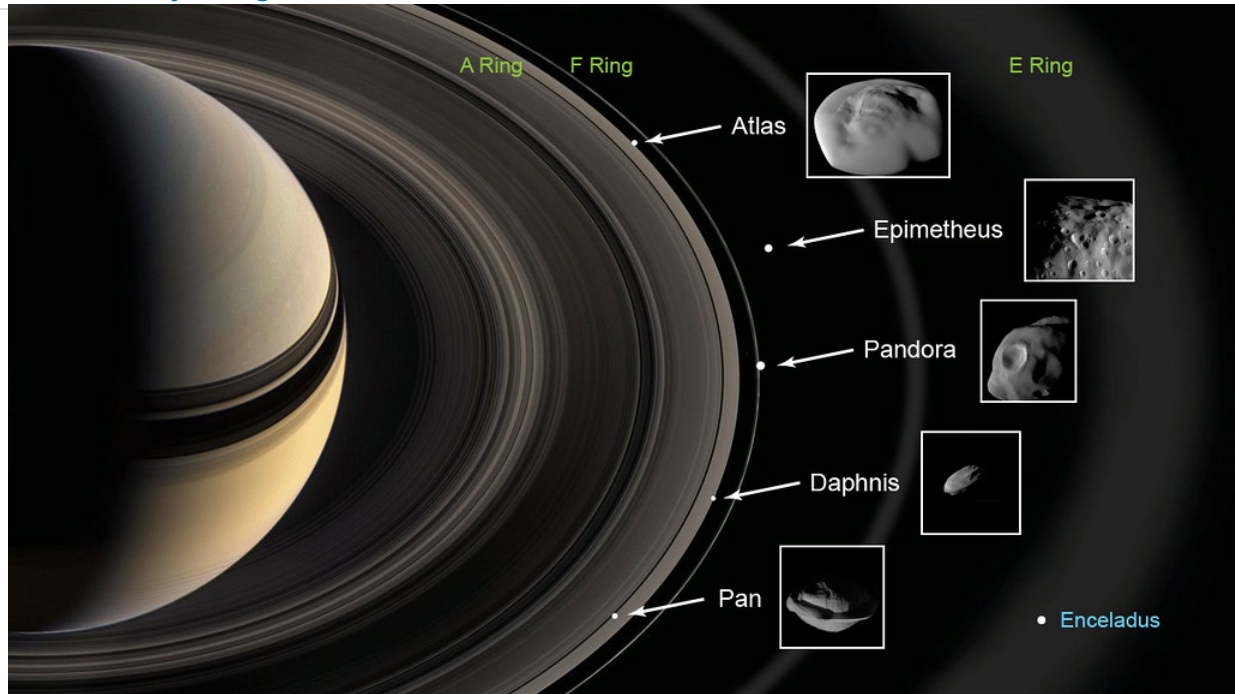


## 12.4: Planetary Rings



Saturn's rings are guided by several "shepherd moons."

<https://www.flickr.com/photos/nasamarshall/40542088413>;

### 12.4.1 Saturn's Rings

The rings are not solid structures. They are composed of small rocky and icy particles. These particles range in size from dust grains to boulders the size of houses. Saturn's rings consist of six main rings, given the letters A, B, C, D, E, and F. The letters were assigned in order of discovery, so are not alphabetically from inner to outer rings. The largest division, the Cassini Division, lays between the A and B rings. The Cassini Division is named after its discoverer, Italian astronomer Giovanni Domenico Cassini, who also discovered four of Saturn's moons in the 17th century. This ring system is 274,000 kilometers (171,000 miles) from tip to tip but dynamical forces keep the rings less than about 100 meters thick.

The Voyager probes showed Saturn's rings to be much more complex than originally thought. Each of the named rings consist of numerous smaller rings bunched together. The Cassini probe passed through a gap in the rings in 2004 at 50,000 mph, giving us the closest view of the rings to date. Cassini suffered 100,000 particle hits in just five minutes, but the density and size of the particles were like that of cigarette smoke, so no damage was done. The gaps can be formed when a pair of small moons force particles into a narrow ring or orbital resonance with a larger moon herds the particles out of gap.

The Cassini spacecraft also revealed many concentric rings. It also found that some small moons create gaps within rings. These moons act as **"shepherd" moons** define the edges of some of the rings. Saturn has several shepherd moons, including Prometheus (F ring), Daphnis (Keeler Gap), Pan (Encke Gap), Janus, and Epimetheus (both A ring). Likewise, some of Jupiter's small innermost moons, namely Metis and Adrastea, may act as shepherds. Uranus' moons Cordelia and Ophelia, also act shepherd moons on its  $\epsilon$  ring.

Neptune's shepherd moon Galatea and possibly other as-yet undiscovered shepherd moons are responsible for clumpiness of its ring system. Shepherd moons get their names because their gravitational attraction nudges particles into their orbits, keeping the rings relative stable, much like a shepherd dog keeps a flock of sheep from wandering away.

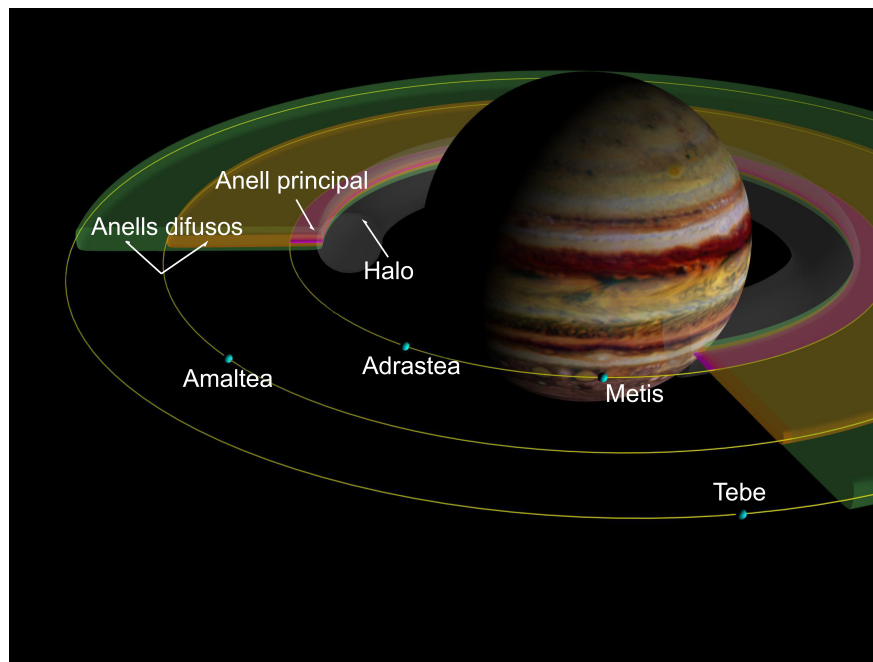
All the observed ring systems occur within what is known as the Roche limit. The Roche limit is the distance from the planet where tidal forces are too strong for a moon to survive. Surveys of the Jovian ring systems do not support the idea that they were once moons that were torn apart from tidal forces. Instead, the tidal forces prevented moons from forming within the Roche limit in the first place. The rings receive new particles to replenish them as particles are knocked off the surface of their icy moons. Impacts on the moons free particles that are then shepherded into the rings. Collisions on the moons are random, so rings may grow or shrink

over time. Evidence indicates that Saturn's rings are relatively young. It is likely then, the Saturn's large, brilliant ring system is simply the result of recent impacts.



### 12.4.2 Rings of the Other Jovian Planets.

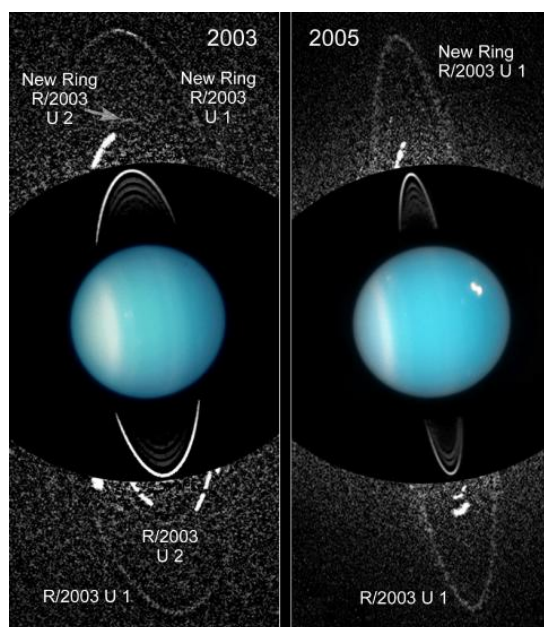
While Saturn has spectacular rings that are visible from Earth, all four Jovian planets have ring systems. The other three ring systems are so faint. They were not confirmed until the 1970s and 1980s by the two Voyager space probes. Jupiter has a small, thin ring system. Its main ring has a sharp outer edge and a diffuse inner edge. It is much fainter and narrower than Saturn's rings. Inside the main ring is another component of the ring system, called the "halo." The halo is a broad, diffuse, donut-shaped ring of particles. Outside the main ring, there are two additional "gossamer rings," that are fainter than the main ring. Jupiter's rings are bound by the orbits of two of Jupiter's small satellites, Amalthea and Thebe. While Saturn's rings are bright, icy particles, Jupiter's rings contain dark, microscopic dust particles. These darker particles have a lower albedo and partially explains why they cannot be seen from Earth.



Jupiter's Rings.

[https://commons.wikimedia.org/wiki/File:r\\_Rings\\_ca.svg](https://commons.wikimedia.org/wiki/File:r_Rings_ca.svg)

Uranus has nine thin rings, which are labeled using Greek letter. Two shepherd moons keep the Epsilon ring of Uranus from diffusing away. Uranus's rings appear to be different than those of Saturn or Jupiter. Instead of broad ring systems, Uranus' ring particles are concentrated into nine or more separate string-like rings, separated by large gaps.

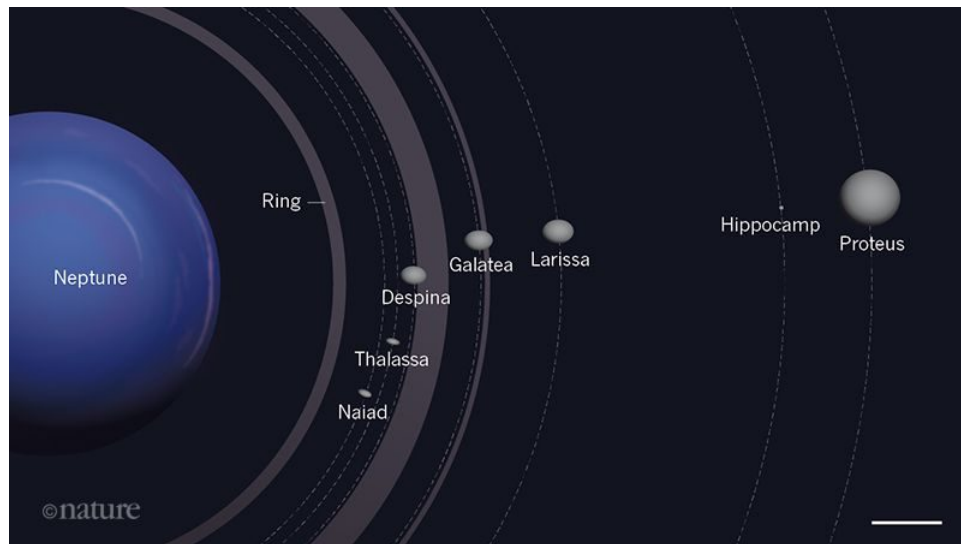


Moon and Rings of Uranus. Note how its rings and moons are oriented to its axial tilt.

[https://commons.m.wikimedia.org/wiki/File:Moon\\_and\\_Rings\\_of\\_Uranus.jpg](https://commons.m.wikimedia.org/wiki/File:Moon_and_Rings_of_Uranus.jpg)

Five rings have been discovered around Neptune has five rings, three narrow and two wide. These rings are like Uranus's rings. Voyager 2 found that the rings of Neptune have clumps of particles that form distinct arcs. Voyager 2, also returned images of several new rings around these planets, along with satellites "shepherding" them.

Besides direct imaging, we can also use occultations to study rings. When a star passes behind the rings, its light dims momentarily, giving information about the location and thickness of the rings.



Neptune and its inner moons and rings.

<https://earthsky.org/space/hubble-solves-mystery-neptune-moon-hippocamp;>



---

12.4: Planetary Rings is shared under a [CC BY-NC-SA](#) license and was authored, remixed, and/or curated by LibreTexts.